U.S. Geological Survey Update

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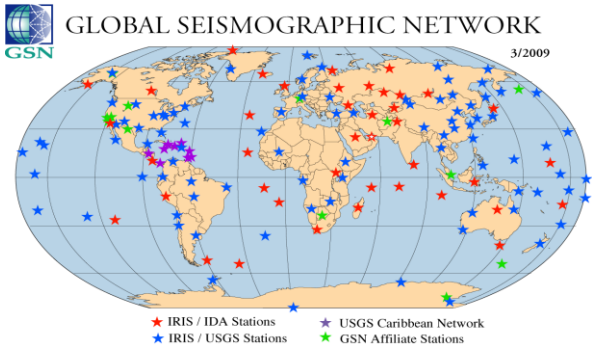
GSN, ANSS and Earthquake Early Warning

Global Seismographic Network – 2017 Plans

- The GSN will begin a **five-year program for installing replacement borehole sensors and improving vaults** at dozens of global seismic stations, improving data quality and thereby the accuracy of earthquake alerts and tsunami warnings, as well as data for basic research.
  - 47 non-functioning or degraded borehole sensors will be replaced over 3 years
  - Sensor vaults and other site infrastructure will be replaced
  - If funded: degraded surface sensors will also be replaced, many with shallow-buried "post-hole" seismometers



Global Seismographic Network – 2016 Accomplishments

- The DOE-funded project to procure new borehole sensors is now in the second phase, which consists of the **delivery and testing of three pre-production units**. In the first phase, a prototype sensor was delivered and testing showed that it met all of the required specifications.
- The **Albuquerque Seismological Laboratory's** (USGS/ASL) **services contract** ended and was successfully recompeted so that a new contract is in place.
- In July 2016, the **US-Russian S&T agreement was renewed** for a period of 10 years, enabling continued exchange of data from GSN stations in Russia.

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Highlights – Advanced National Seismic System

- NEIC response to the Nepal earthquake and the N. Korea nuclear test.
- New permanent hires in NEIC real-time products task as part of FY2014 increase for CEUS: 2.5 FTEs (Jaiswal, Thompson & Allstadt).
- Improved coordination for temporary deployments for induced seismicity sequences.
  - In 2015, USGS had ~60 temporary stations out in Oklahoma, Kansas and Texas, coordinated with ststes and universities.
- Development of PRISM software for streamlined posting of strong motion data products to Center for Engineering Strong Motion Data.
- Improvements to Anchorage strong motion network, resulting in high data return and great data from the January 2016 M7.1 earthquake
- As part of FY2015 EEW increase, regional seismic network upgrades along the West Coast that will add 150 EEW capable stations
  - (under new EEW 2 year agreements with Caltech, UCB, UO, and UW.)
- New 5 year cooperative agreements with seismic and geodetic networks.
  - Improved support for U. Oregon component of the PNSN, both from USGS and the State/University. Includes State of Oregon funding the purchase of 15 Cascadia Initiative stations.
- Proposed long-term operation of the Central and Eastern U.S. seismic net.

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The Path to ShakeAlert

Development Phases:

I. 2006-2009 – R&D, network upgrades

II. 2009-2012 – operationalize, more upgrades

- CA: *Demo System - Live Jan. 2012*

III. 2012-2015 – Demo to Production Prototype

- PNW: *Demo System - Live Feb. 2015*

IV. 2016-2017 – continued improvement, testing

- CA: Production Prototype - Live Feb. 2016

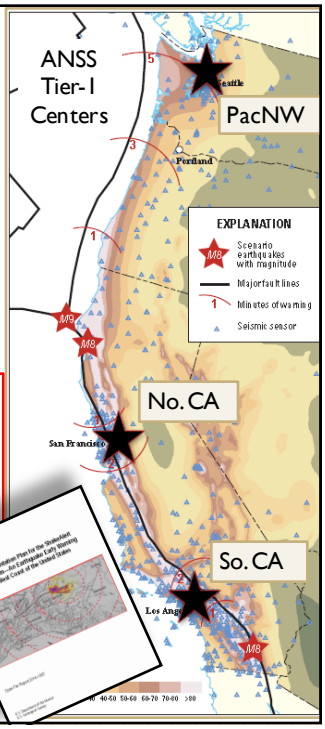
- add PNW: WC Production Prototype, fall of 2016

- Target station density in Metro L.A. and Bay Area

- Pilot applications

V. 2018 – limited public roll-out

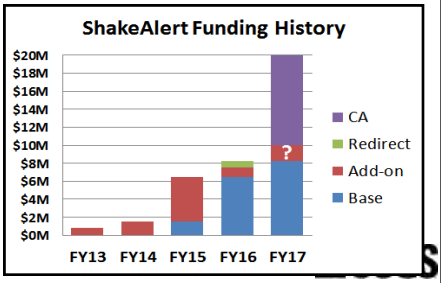
VI. ? - Full Public Operation (depends on funding)



ShakeAlert Funding Outlook

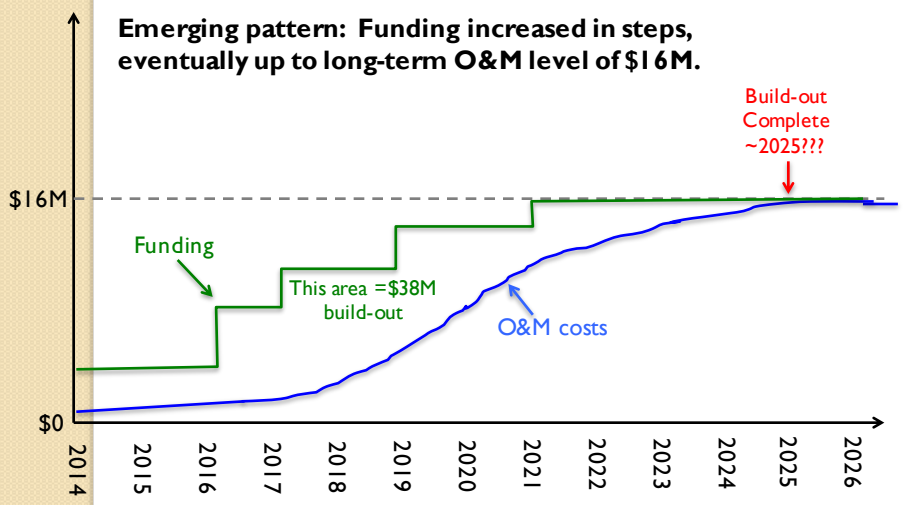
- Federal (USGS)
  - FY14 $1.5 M
  - FY15 $6.5 M
  - FY16 $8.2 M
  - FY17 $8.2 M ?
- California
  - FY16-18 $10M
- Oregon
  - 2015-16 ~$1M
- Moore Foundation
  - $10.1M (ended)

Estimate from implementation plan	California	Pacific Northwest	*West Coast Total*
Construction	$23.1M	+ $15.2M	= *$38.3M*
Annual Oper.	$11.4M	+ $4.7M	= ***$16.1M***



Funding the development of EEW

Emerging pattern: Funding increased in steps, eventually up to long-term O&M level of $16M.



Alaska Study - Congressional Direction

Report language for the Interior and Environment portion of the FY2016 Omnibus appropriations legislation directed the USGS to "*conduct a cost benefit analysis and spending plan for the adoption of any remaining seismic stations, including stations in final deployment, if included as part of the Survey's Advanced National Seismic System for Research.*"

Implied in this wording is the *Earthscope* Transportable Array (TA) deployment in Alaska, 2016-2018

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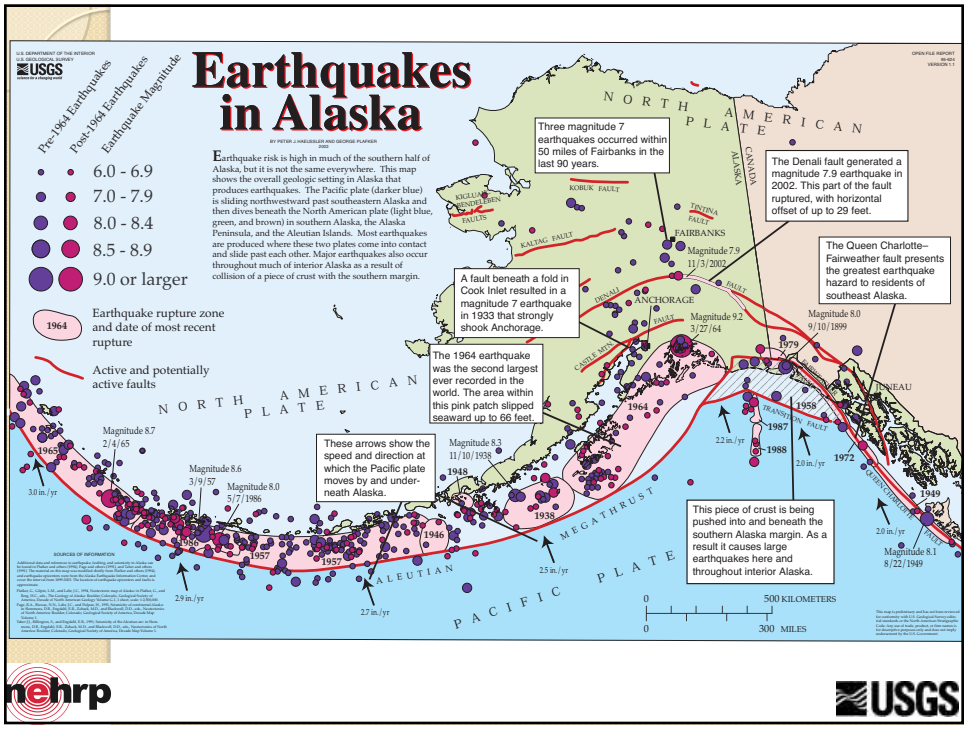
Earthquakes in Alaska
Pre-1964 Earthquakes
Post-1964 Earthquakes
Earthquake Magnitude
6.0 - 6.9
7.0 - 7.9
8.0 - 8.4
8.5 - 8.9
9.0 or larger
1964
Earthquake rupture zone and date of most recent rupture
Active and potentially active faults
Earthquake risk is high in much of the southern half of Alaska, but it is not the same everywhere. This map shows the overall geologic setting in Alaska that produces earthquakes. The Pacific plate (darker blue) is sliding northwestward past southeastern Alaska and then dives beneath the North American plate (light blue, green, and brown) in southern Alaska, the Alaska Peninsula, and the Aleutian Islands. Most earthquakes are produced where these two plates come into contact and slide past each other. Major earthquakes also occur throughout much of interior Alaska as a result of collision of a piece of crust with the southern margin.
Three magnitude 7 earthquakes occurred within 50 miles of Fairbanks in the last 90 years.
The Denali fault generated a magnitude 7.9 earthquake in 2002. This part of the fault ruptured, with horizontal offset of up to 29 feet.
The Queen Charlotte–Fairweather fault presents the greatest earthquake hazard to residents of southeast Alaska.
A fault beneath a fold in Cook Inlet resulted in a magnitude 7 earthquake in 1933 that strongly shook Anchorage.
The 1964 earthquake was the second largest ever recorded in the world. The area within this pink patch slipped seaward up to 66 feet.
These arrows show the speed and direction at which the Pacific plate moves by and underneath Alaska.
This piece of crust is being pushed into and beneath the southern Alaska margin. As a result it causes large earthquakes here and throughout interior Alaska.
NORTH AMERICAN PLATE
PACIFIC PLATE
ALEUTIAN MEGATHRUST
FAIRBANKS
ANCHORAGE
KODIAK
JUNEAU
Magnitude 7.9 11/3/2002
Magnitude 9.2 3/27/64
Magnitude 8.7 2/4/65
Magnitude 8.6 3/9/57
Magnitude 8.0 5/7/1986
Magnitude 8.3 11/10/1938
Magnitude 8.0 9/10/1899
Magnitude 8.1 8/22/1949
500 KILOMETERS
300 MILES
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Alaska critical facilities
Norton Sound
Kotzebue Sound
Bristol Bay
Gulf of Alaska
Image IBCAO
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Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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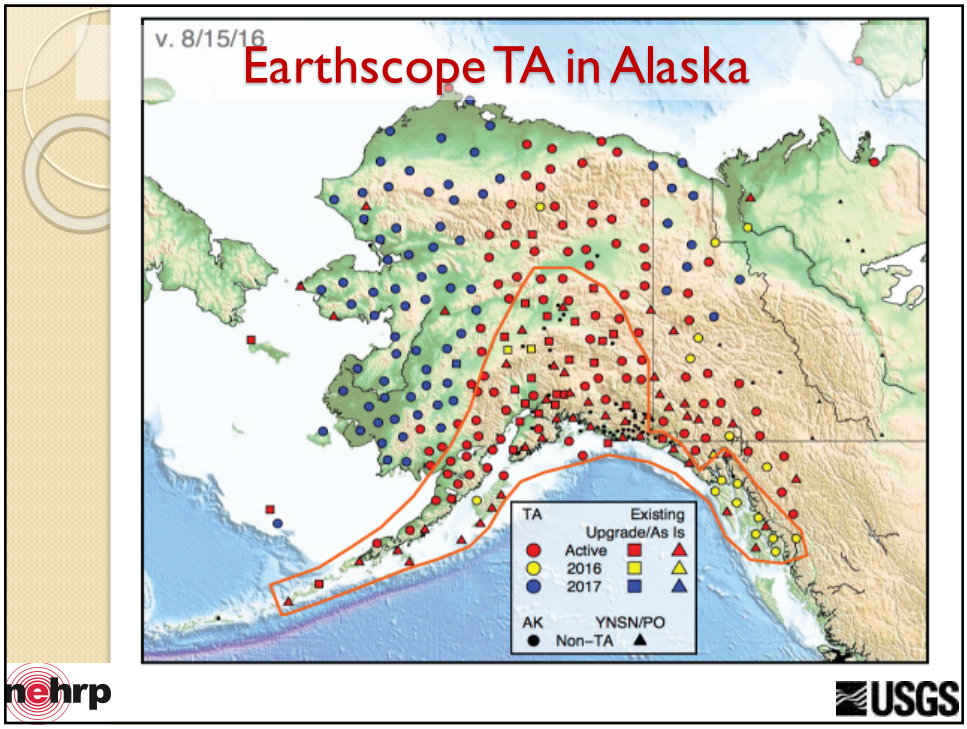
v. 8/15/16
Earthscope TA in Alaska
TA
Existing
Upgrade/As Is
Active
2016
2017
AK
YNSN/PO
Non-TA
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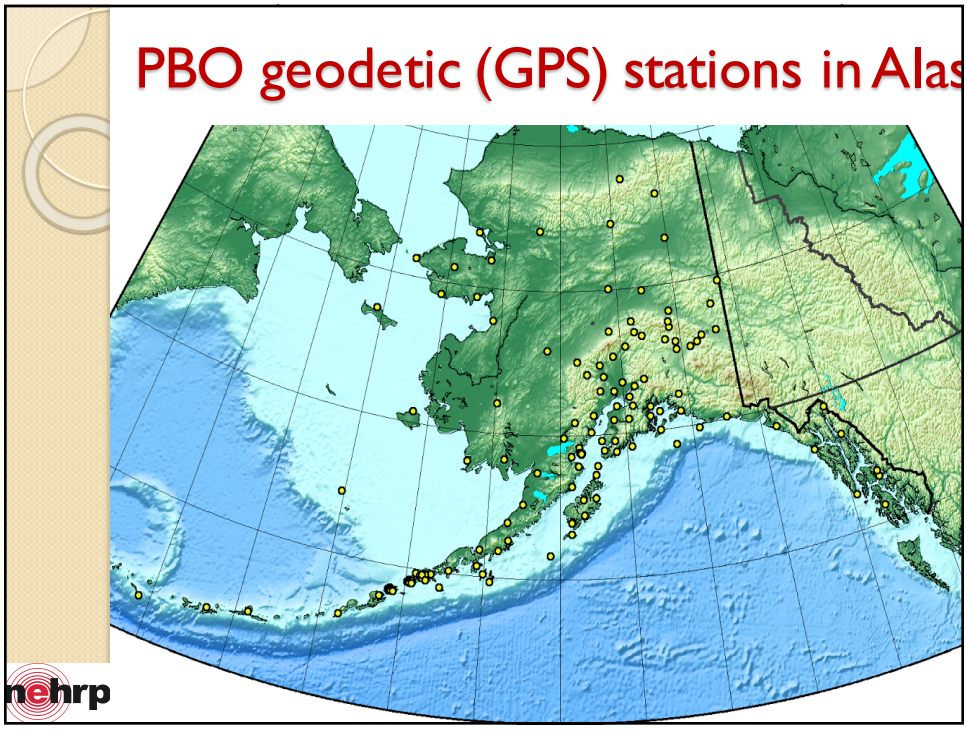
USGS


PBO geodetic (GPS) stations in Alas
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Alaska Earthquake Monitoring Working Group

C.B. Crouse, AECOM (representing ANSS Steering Committee)
Jeffrey Freymueller, University of Alaska, Fairbanks
Doug Given, USGS EEW Coordinator
Peter Haeussler, USGS Alaska Coordinator for EHP
Steve Masterman, State Geologist, Alaska
Michael O'Hare, AK Div. of Homeland Security and EM
David Oppenheimer, USGS (Chair)
Susan Schwartz, UC California Santa Cruz
Paul Somerville –AECOM
Paul Whitmore NOAA NWC
David Wilson USGS (representing NEIC)

AEMWG contained expertise in earthquake research, seismic monitoring, emergency management, earthquake engineering, tsunami warning, geology, and geodesy.

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Committee Charge: A broad cost benefit study for improved earthquake and tsunami monitoring seismic hazard assessment and research

AEMWG was asked to broadly consider and prioritize any improvements to earthquake monitoring which are aligned with the priorities ANSS, including:

Transportable Array (TA) adoptions
Earthquake Early Warning (EEW)
Alaska Earthquake Center improvements
Strong motion network improvements
Geodetic monitoring capabilities

Additionally, the committee was instructed to consider coordination with the NOAA tsunami warning centers

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AEMWG established the following benefit types* of improving earthquake monitoring in Alaska:

- improving earthquake hazard assessments (the basis for the seismic provisions of building codes)
- improving engineering designs for buildings, bridges and other infrastructure
- earthquake early warnings for population centers
- improved tsunami warning
- improved public safety, and post-earthquake response, and recovery
- research on the causes and consequences of earthquakes

*from the NRC 2006 study: "Full deployment of the ANSS offers the potential to substantially reduce earthquake losses and their consequences."

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Next steps

The AEMWG only considered Alaska-relevant needs.

To obtain broader context and help with prioritization, this plan will be referred to the USGS Earthquake Hazards Program's external advisory committee, the SESAC. As a FACA, the SESAC alone can make recommendations to the USGS on the importance of the items identified in this study relative to other national needs.

The USGS must assess this study in the broader context of national priorities for ANSS and other earthquake loss reduction activities. Nationally, ANSS is only partially built, and most of its component regional seismic & geodetic networks have resource challenges.

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